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ABSTRACT

This paper is a theoretical description of the mental processes that occur as part of teachers classroom behavior. Concepts are applied from the field of cognitive science and the following model is offered: the brain has an intrinsic dynamic nature with hierarchically organized levels of functioning; there is a large degree of interconnectedness between individual neurons, groups of neurons, and systems of neurons; and there is a continuous stream of parallel and temporal information processing through these connections. The development of methodical teaching behavior follows from the assumption that teachers will become better able to steer or modify their classroom behavior in accordance with the demands of the environment. Teachers must frequently react quickly to classroom situations and this prevents reflection on action with the responses coming from lower levels of subconscious behavior rather than higher. Therefore, teacher improvement must focus on making certain teacher behaviors part of the subconscious response. The challenge for teacher training and staff development is to help student teachers perform subconsciously in a way that is effective in promoting student learning. Teachers must be taught new behavior that is at first counter-intuitive for them but that with practice will become part of their subconscious. (Contains 18 references.) (JLS)

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The relation between teacher thought and behavior, implications for teacher training

Paper presented at the 1996 Annual meeting AERA, New York

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Introduction

Professionalisation of teachers can be studied and enhanced on several levels. The main levels are the level of the individual teacher and the level of the professional group in a school, society or country (Jansma, 1995). In this paper we focus on the individual level. We develop a theoretical description of processes when teachers act in classes and develop from that some guidelines to promote teacher learning as part of professionalisation.

On this individual level professionalisation of teachers is the process of development of their repertoire of methodical behavior, that includes development of the ability to make sense out of experiences in specific contexts. We use "behavior" for the manifestations of the individual in his or her environment. Cognition mediates between the external environment and the teacher behavior. Cognition is used to refer to the meaning making processes (Bruner 1990, 2) internal to the individual which accompany the behavioral manifestations. Methodical behavior includes conscious cognitive processes. Professionalism means then that meaning making processes are such that effective and efficient teaching behavior becomes manifest. This paper therefore starts from a cognitivistic perspective on teacher professionalism.

This paper is a report of work in progress and certainly we will have to revise some of our assertions. We are however rather sure that the model for teacher behavior and cognition presented will give us important clues for training.

A model for teacher behavior and cognition

the physical substrate of psychological phenomena

One of the basic assumptions of cognitive science (Gardner, 1987) is that people hold mental representations of their environment. Build from innate potential through perception of and interaction with the environment the organism's mental representations in their turn guide perception and interaction. In studying this process we try to take into account the growing body of knowledge about brain functioning which we regard as the physical substrate of psychological phenomena.

Sejnowski & Churchland (1989) give an overview of what they call neuro-biological constraints on cognitive mechanisms. The following core principles are derived from neurobiological theory and underlie the model that we propose:

- the intrinsic dynamic nature of the brain;
- hierarchically organized levels of functioning;
- an incredible large degree of interconnectedness between neurons, groups of neurons and, what seems to be, systems of neurons;
- a continuous stream of parallel and temporal information processing through these myriads of connections.

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The almost inevitable conclusion arising from insight into the staggering complexity of the brain is that every model and every metaphor for cognition, except may be William James's "Stream of consciousness" is bound to fall short of reality.

Because of the dynamic nature of the brain we view psychological phenomena as dynamic[2]. Moreover, we see all psychological functioning as integrated because of the interconnectedness of all parts and levels of the brain[3]. Mental representation is a physical reality in the sense that interactive experience is mirrored in relatively stable patterns of synaptic connections between neurons and groups of neurons and the relative strength of those connections in terms of excitory or inhibitory power.

With regard to the relation between perception, cognition and behavior we propose for the physical level the metaphor of a programmatic unity between perception, cognition and behavior. A program then is the performance of the nervous system in processing a particular stimulus complex. In a program functional processes in various parts of the nervous system can be integrated, eventually leading to behavioral output.

cognitive mediation

In the introspective perception of the subject, the cognitive mediation between perception and behavior has various forms. It can, for example, be unperceptible, an unconscious process that leads to an autonomous reaction. Or it can be deliberate decision making. The claim that teachers are conscious decision makers or even reflective practitioners for much of the school day, however, cannot be held up. Yinger (1986) showed that no more than 25 per cent of teachers' behaviors could be traced down to conscious decision making. Much of teachers' behaviors are not based on logical analytical information processing but rather on sub-rational, some times unconscious, information processing (see Wubbels 1992; Korthagen 1993). Many behaviors of teachers are routines or on the spot, even split second reactions in which reflection plays only a limited role. That is not to say that these routines or reactions would not be appropriate from a professional point of view. Routines and automated reactions are a necessary part of a teacher's professional repertoire (Au and Kawakami, 1984).

In order to understand the different types of cognitive mediation we have to differentiate our basic model further. At every moment in the brain myriads of continuous processes of activation and inhibition in and between groups of neurons take place. When external stimuli are entering the human body through the senses, roughly, in certain fields of the brain neural activity intensifies. After some time these fields turn back to less intense patterns of activity as they showed in their previous state.

We can think of the actual pattern of excitation and inhibition at different levels of organization in the nervous system as a path through a program. Another metaphor is Gestalt which seems more appropriate to capture the holistic nature of the flow and distribution of neural activity in the cortex which accompanies behavior. In scans of this activity it can be seen that several regions are activated at the same time, some become in the fore, while others are background (....).

Of the two, the path metaphor is better suited to capture in a model. The various phases of the program, the path runs through for example can be found in the model Frijda (1986) proposes to explain emotional behavior. This model can be mirrored by one which describes the

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[2] Memory for instance seems to be more appropriately described by referring to a continuous process of construction and reconstruction instead of a vast storage of fixed images (e.g. Rosenfield, 1988; see for an overview of cognitive theory with regard to memory Schacter, 1989; for an overview of neuropsychological findings in general (and e.g. with regard to memory) see Kolb & Whishaw, 1990).

[3] For example Lurija (1973) while being one of the first to distinguish between subsystems in the nervous system from a psychological point of view, explicitly stresses the need to view the functioning of the nervous system as a whole.

parts of the nervous system playing a functional role in the program. Such a model can be based on neuro psychological theory. Lurija (1973) may well be regarded as the forerunner of theorists who tried to describe and explain the interplay of functional processes in the nervous system with regard to functions like self-consciousness, language and rational behavior (e.g. Popper & Eccles 1977, Edelman 1989). In the models mentioned three core functions are distinguished. Of course the perceptory function is one of the three, the processing and integration of stimulus complexes originating in the environment. Equally important is the processing and integration of information with regard to the physiological needs of the organism. Those needs find their basic expression through the internal homeostasis systems, and information from those systems feed into various parts of the nervous system and from there is distributed to other parts. Information from the environment and information from inside the organism is integrated and fed into the the motor function[4].

Most contemporary theory with regard to neural interaction is based on the model of parallel distributed processing (Rumelhart & McClelland, 1986). We assume that when a perception leads to behavior, many patterns of neural interaction at various levels and in various regions of the brain change in parallel and serial processes at the same time as showed in figure 1 (Greenwald, 1992). Information originating in a stimulus complex is distributed over several neural regions and the connection between stimulus and behavior is part of many simultaneous programs within subsystems of the nervous system. One such program delivers, given a certain input, a specific output to fulfill a specific internal (cognitive) or external (behavioral) function.

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figure 1

The model describes parallel information processing in addition to serial that was assumed in earlier models. Serial models made it difficult to explain phenomena such as awareness because then awareness of a stimulus would be necessary before behavior in response to the stimulus. In parallel processing awareness can arise after the response.

hierarchal organisation of behavioral programs

Neural activity in a functional program can be interpreted as leading to an action tendency. At the same moment always other programs are processing information. Which one is dominant and provides the behavioral output depends on the stimuli as well as on the internal states.

In order to characterize the output we need to look at the different hierarchically structured and dynamically related layers in the brain that steer behavior (see also Jansma, 1995). At all levels outputs are delivered, but for the external manifestations it is important which possible output of a functional program becomes dominant at a certain time.

We propose a distinction of four levels in behavior programs: unconscious, sub-conscious, conscious and self-conscious and consequently behavior can be steered at these four levels. Unconscious means that the person cannot report in any way about his or her cognition and is not aware of it. We use sub-conscious for the state in which someone is aware without being able to tell about it. The person cannot make his or her awareness explicit in language. The state in which such an expression is possible we call conscious. Language is not necessary for that. The sub-conscious and conscious layer are accessible for reflection. This means not necessarily the ability to speak or hear or write, but to think either in language or in images etc. As soon as we turn our attention to our behavior we call the behavior self-conscious.

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[4]: Functions like memory and attention are of a different kind. At various levels of organisation those functions are served by brainstructures which also serve the functions we distinguish.

The different levels of behavioral steering described above can be seen as different layers in the model of parallel distributed processing because in this model processes are hierarchically ordered. The lowest levels are processes that develop unconsciously for the person and they can deliver steerage of autonomous physiological processes as output. On a higher level more complex functions can be performed sub-consciously such as when driving a car. Many of the behaviors of teachers are sub-conscious automatic responses to perceptions of the environment. Both for visual information and for language processing and also for complex processes such as recognition of faces and reading these sub-conscious reactions have been shown (Kolb & Whishaw, 1990; see also Greenwald, 1992). At this level learned automatic behavior is expressed. It is possible that the connection between the lower level processes and higher level processes is so strong that we turn our attention to the relation between stimulus and behavior on the lower level process so that the behavior becomes self-conscious. If the lower level activity goes only slightly into the higher levels of processing we are sub-conscious or conscious but not self-conscious. In this state it is probably hardly possible to interfere in the process. We can "see" what happens but we cannot deliberately change that process. If the change of neural activity penetrates deeper into the higher layers self-consciousness arises which means that via connections to language the awareness of the process can be described and can be changed.

internal states

What path through the program will become dominant and will deliver a behavioral output depends on both the perceived stimuli and internal states.

Biologically, internal states are relatively stable patterns of synaptic connections between neurons and groups of neurons and the relative strength of those connections in terms of excitory or inhibitory power. Psychologically, the internal states represent such concepts as attention, needs, values and motives that are partly innate and partly a result of earlier experiences. We think of these internal states as internal value-configurations, mediating the needs of the organism, and the environment as a source for the fulfillment of those needs.

Also in the value-configuration we distinguish a hierarchical organization. At the basic level the physiological needs of the organism find their expression in the motivational dimension of behavioral programs. Probably the individual has some innate behavioral programs at his or her disposal. Through experiences this core repertoire is extended and nuances are build through interaction with the environment which to a great extent is socially mediated e.g. by parents and other socializing agents. The second is the level for cultural survival and includes the need for social relationships, certainty and recognition. Thirdly we have the level of volition, free will in which individuals in the cultural environment can shape some of their needs in a self-conscious way: self-actualization. From this description it is clear that we have reduced Maslow's hierarchy of needs to a three level model.

Experiences are represented in the internal states. Every experience leads to lasting changes in the pattern of activation and inhibition in a dynamic system. If a certain experience leads to a behavioral output the dynamic system has delivered an output and less stimuli may be needed a next time if a similar stimulus is perceived.

Steering of behavior

A higher layer of the internal state can only steer behavior as long as the paths through lower level programs do not provide a behavioral output. If more basic needs are not fulfilled the chance increases that the lower level programs take precedence in steering the behavior (see also Frijda, 1986). It has been shown that activation in the brain can take slower, conscious, and faster, unconscious or sub-conscious, pathways with similar behavioral manifestations (e.g LeDoux, 1990). Quick teacher reactions are the result of low level steerage in the hierarchy of internal states. If we want a teacher to have behavior steered by higher levels, lower needs must be fulfilled. If we want teachers behavior to be steered consciously or self-consciously, then it is

important to have immediate reactions inhibited. That means that techniques to make mediation conscious have to be employed.

Professionalisation

This paper focusses on an aspect of professionalisation: the development of methodical teaching behavior. In our model this implies that teachers become better able to steer their behavior in accordance to the demands of the environment. For improving teaching it is important to consider that teachers in class have to act on the spur of the moment. Therefore reflection in action is hardly possible and lower level programs will deliver sub-conscious behavior.

Sub-conscious reactions may be effective from the point of view of survival. They may however not be the most effective for a teacher to promote student learning or create a positive learning environment. For example the tendency to answer a question is an effective everyday response if students ask a question, but teachers often better react in an other way (give the question to another student, or ask a question in return, or give a hint to make students able to answer the question themselves, etc.).

A challenge for teacher training and staff development is to help (student) teachers to perform sub-consciously in a way that is effective from the point of view of promoting student learning. To achieve this, it can be necessary to help teachers show other reactions than what they intuitively do. When other behavior has been learned and practiced, there always still is the possibility that in new situations a certain perception will prompt again a response that has been judged already inappropriate in certain situations. This is a consequence of the fact that paths through programs that prompt a behavior on a particular stimulus cannot be removed or erased and these always can again deliver the inappropriate output. Therefore if teachers learn to behave in new ways, inhibition of paths that may be likely to deliver a less appropriate output is necessary. Teachers in these situations need to develop a way to react counter-intuitive but also in a highly automated way.

By having performed in some counter-intuitive way frequently a new path or programpotential has mediated between perception and behavior and this may make this ppotential path dominant to another low level path in similar situations. The more often behavior has been the result of certain stimuli the more probable it is that similar stimuli later on will raise similar behavior and that other potential reactions are inhibited (....).

In order to get more deliberate conscious behavior teachers can force themselves to take a time out, that means that the lower functional programs have to be inhibited. In case of a chosen time out such inhibition is a result of self-conscious interference in what first were sub-conscious processes. Certain behavior tendencies do not become manifest and deliberately other behavior is shown. For example a teacher may be inclined to punish a student who makes a stupid remark without thinking about it. He or she can train himself to become aware of this reaction and instead ask what the student means with this remark. For this type of change it is necessary for teachers to train themselves to take a time out whenever a student makes a stupid remark, that means raising awareness in particular situations and recognizing these situations probably by focussing on internal messages such as feelings of anger.

As said before, teachers' sub-conscious reactions are faster than conscious or self-conscious level reactions. This is important from the point of view of effective teaching. When a teacher is performing consciously after several similar reactions in similar situations the new reaction may become automatic and sub-conscious and thus a second type of inhibition is reached. When the second inhibition is in use the teacher has "learned" to react sub-consciously in a different way from before. Other lower level paths then have taken over from the original. In the end this second type of inhibition is more efficient than the first, self-consciousness. The first one can be, however, a necessary means to reach that state in a learning process.

Promoting learning of other behavior

We have presented in earlier work overviews of ways that have been proposed to change (student) teachers' conceptions and teaching behavior. These included such diverse approaches as strategies for conceptual change, behavioral assignments, reflective strategies, etc. (Korthagen, 1993; Wubbels, 1992). The theoretical framework developed in this paper gives some clues for the criteria that need to be met by strategies in staff development and teacher training in order to achieve professional development that will not only influence teacher thinking but also teacher behavior. We discuss five strategies from this point of view.

Behavioral and conceptual change

The most frequently described conceptual change strategies (e.g. Stofflett & Stoddart, 1994) include such phases as becoming aware of conceptions, becoming dissatisfied with these conceptions for example on the basis of new experiences (e.g. different information), exploring alternative conceptions and choosing a more appropriate one. This can be interpreted in our model as making the sub-conscious reactions conscious, and develop other potential reactions or behavior tendencies. The model shows that the likelihood for success will be larger if training and coaching of the actual behavior consistent with the changed conceptions is part of these strategies. Otherwise the strategy may lead to new behavioral tendencies that will not become manifest in behavior because in the actual teaching situation the program potential used before to deliver an output will stay dominant. The pressure to act on the spot will make the lower level programs deliver an output instead of the new ones that only can perform consciously. The latter require when they are conscious a time out and are still slow. Frequent use can make these slow reactions faster and finally sub-consciously automatic. The more often a new program has delivered an output the easier it will be for that program to become dominant (.....). Thus training in using better behavior is necessary to have new conceptions lead to better teaching.

New experiences

New experiences, different from earlier ones can be a starting point for development of different behaviors in new situations as well as in familiar ones. In order to have particular behavior promoted, particular perceptions of the experience are necessary. So one might make a teacher aware of certain aspects of the environment or might bring teachers in a different environment. This may activate program potential that have not often been activated before thus giving new behavioral capacities. In order to be successful it is best that the new experiences are organized in such a way that the appropriate behavior is evoked at once. If at first inappropriate behavior is evoked a potential has been reinforced and thus the probability is enlarged that in future this path will be activated through the program and will deliver the same inappropriate output again. This means that careful preparation of the learning environment for (student) teachers is important to ensure that student teachers will react appropriately. If in a school a student teacher is brought in a new situation such as a problematic class, and the student reacts intuitively in an aggressive way (a path in a low level flight/fight program) then this (inappropriate) reaction can be repeated more likely in future. If on the contrary the student teacher has been prepared on campus through among others behavior training to react in another way the school situation may become a more productive learning environment. In order to promote flexible use of the new behavior capacity it is helpful if the new behavior is not only showed but if afterwards also reflection is organized so that the student teacher becomes aware of the behavior and the perception that has led to that behavior.

Acting in the mind

Neural activity that is very similar to the activity accompanying actual behavior can be stimulated by thinking of acting (....). This gives ground to training procedures in which (student) teachers think about situations and what they would do. To be effective, they need to go in their mind

through the whole sequence from perception (as rich as possible in imagination) to behavior including to imagine the exact behavior that they want to perform. The more realistic they think about these situations in a lively and imaginative way including smells, sounds etc., the better they can assure that they will display in the actual situation the behavior that they think of when preparing their actual performance.

Modelling

A strong tool in teacher training is modelling, the trainer shows the behavior in a particular situation that (student) teachers should learn. It gives the (student) teacher the opportunity to perceive the situation and the manifest behavior. Thus, in the brain a program is activated that will closely resemble the program that in the trainer prompts the behavior that is modelled. So similar to the situation of acting in the mind the program that can deliver the appropriate output is activated to develop the behavioral capacity. In order to promote flexible use of the new behavior capacity it is helpful if the new behavior is not only modelled but if afterwards also reflection is organized so that the student teacher becomes aware of the behavior and the perception that has led to that behavior.

Behaving

If people act in a certain way because they follow a command in a situation where the environment demands that behavior, the program that delivers the appropriate output is strengthened. Thus the starting point for development of an automatic reaction lies in the final behavior. This will be a rather quick way to get the behavior in the automatic phase, because the way the behavior is showed first resembles already that phase more then when behavior is completely self-conscious. The drawback of this type of training (as well in some of the other forms described above) is that the use of the new capacity can be rigidly bound to the situation where it was used at first. Therefore this powerful type of training is only suited to get the behavior in use. For flexible use of the behavioral capacity, however, reflection (making the connection between perception and behavior conscious) is necessary.

Epilogue

Our research activities at this moment follow three tracks to operationalize the model presented in the beginning of this paper. Along the first track we try to construct stylized representations of what we call teacher's mental models with regard to their role-perception. Jansma constructed a hypothetical model in which four functional dimensions are distinguished. Operationalizations of this model and the four dimensions are under way, aiming at the construction of an instrument for interviews and questionnaires with regard to diagnosis of teachers cognitive position in schools under change.

Along the second track we work in collaboration with various schools who work towards reform of their organization and improvement of their educational practice. In this collaboration we try to stimulate, structure and sustain reflective (action) processes at the level of individuals and groups in the schools with regard to the changes they experience while working at developmental projects in their school. The progress we make while operationalizing the stylized models for role-perception is used to feed into the reflection-track and vice versa.

Thirdly we develop instruments to measure aspects of the programs that steer teachers behavior in reactions in class (Dolk, Korthagen & Wubbels, 1995). Currently these instruments are being tested on reliability and validity and the results are encouraging. One such instrument is a variation of the repertory grid with descriptions of student work as input for the elicitation of constructs. Another uses drawings as a starting point for interviews.

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